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IONOSPHERE TEMPERATURE MEASUREMENT BEGINNING FROM THE ROTATION SPECTRUM OF THE AlO MOLECULE

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(Presented by M. André Danjon)

IONOSPHERE TEMPERATURE MEASUREMENT BEGINNING FROM
THE ROTATION SPECTRUM OF THE AlO MOLECULE *

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We demonstrated in 1960 that an explosion at 150 km altitude creates a cloud visible at twilight and that the light emitted by the cloud is due to the optical resonance of the AlO molecule excited by solar light [1]. We repeated our 1960 experiment by means of a Veronica rocket launched on 24 May 1962 at 2040 hours local time (solar depression angle : 9°) at Hammaguir (Algeria), bearing a load of 58 kg of exogenous tolit (trinitrotoluene). The explosion took place at 170 km at $T_o = 20 h 43' 32''$ and created a cloud visible during 20 minutes. Three spectra were obtained by means of our REOSC spectrograph with grating (f/2,3), between 4500 and 5250 Å, with the following exposures (film 103 aD):

Beginning of exposure	End of exposure
T_o	$T_o + 1 m 30 s$
$T_o + 2 m 30 s$	$T_o + 4 m 30 s$
$T_o + 5 m 30 s$	$T_o + 20 m$

These three spectra, photometrically calibrated with the aid of a Barbier-Soleillet wedge, and fixed in wavelength, allow the study of the rotation structure of the 0-0 branch of the

* Mesure de la température de l'ionosphère à partir du spectre de rotation de la molécule AlO.

$X^2\Sigma^+$-$A^2\Sigma^+$ transition of AlO between 4 840 and 4 865 Å, excited by the Sun.

Assuming that the cloud is nearly immediately in thermal equilibrium with the neighboring atmosphere and that the popution N_j avec each of the rotation levels obeis the Boltzmann law:

$$N_J \propto (2J+1)\, e^{-\frac{B_e J(J+1)hc}{KT}}, \qquad B_e = \frac{h}{8\pi^2 c I},$$

where I is the molecule's moment of inertia, we may calculate the temperature T of the atmosphere.
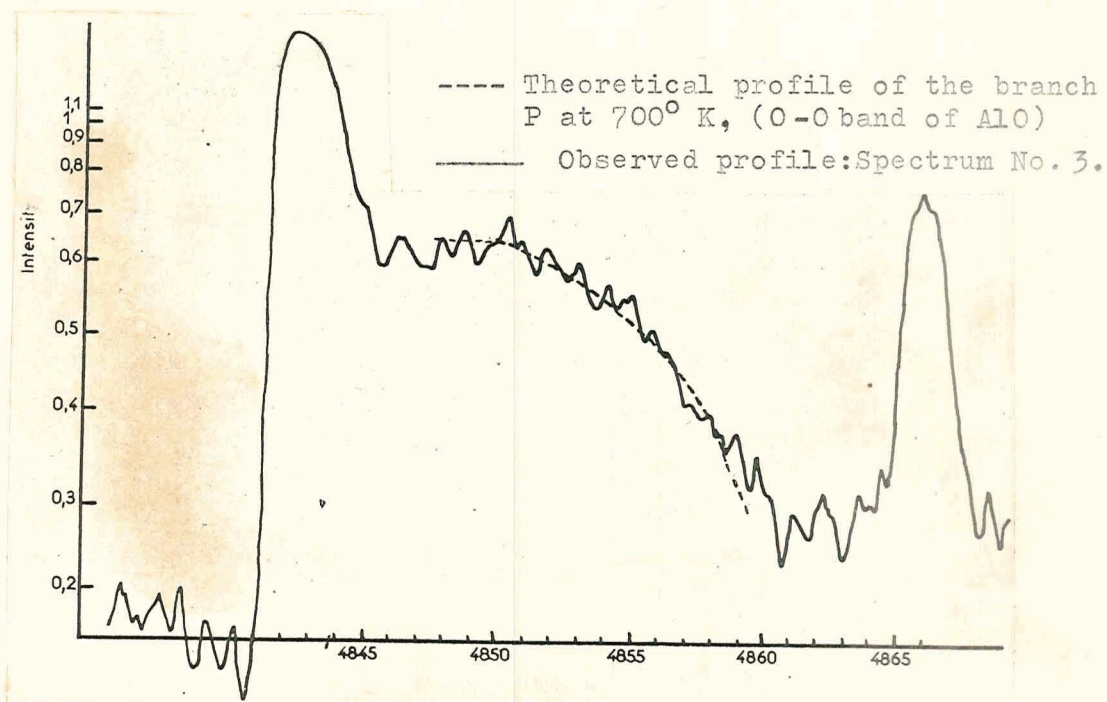
We have adopted for B_e the value 0.64148 [2] corresponding to the fundamental state, assuming the lifetime of the excited state very short.

Since we study the transition only the branches P and R appear, and we utilize the branch P. The recurrence of the branch R is not troublesome for only lines R_j overlapping the branch P are those of index $J \leqslant 37$ whose intensity at low temperature is weak. We took this into account.

In the studied region the spectrograph's resolution does not exceed 1.5 Å, while the distance separatibg the lines varies from 0.3 to 0.8 Å. We therefore utilized the following method :

Taking for every line the wave number given by Pomeroy [3], we calculate with the preceding hypotheses the population's N (J) logarithm a priori for the different rotation levels J. This curve is corrected by adding to log N (J) the logarithm of the corresponding exciter-solar intensity given by the Utrecht Atlas, which gives us the "true" n (J) population. Each line is thus assimilated to a triangle of ordinate n (J) for height and of base 3 Å (which corresponds to the resolving power of 1.5 Å) in agreement with the function of the device obtained from the

reference spectrum for argon present on the same film. The intensity I at each point is calculated by integration of the contributions of every line every 0.6 $\overset{\circ}{A}$, whence a curve $\log I = f(\lambda)$ is obtained

---- Theoretical profile of the branch
P at 700° K, (0-0 band of AlO)

——— Observed profile: Spectrum No. 3.

A group of these curves was computed for the tempertures of 300, 400, 500, 600, 700 and 800° K. As to the effect of the branch R_j, since the probabilities of transition $J = \pm 1$ are equal, two lines of the same J of branches P and R have the same intensity (to be corrected by the exciter solar intensity). We then proceed as for the branch P and we add the contributions of both branches. The recurrence of the branch R is felt above 600° K.

In order to take into account the response of the photo plate, we make the maximum of the reconstituted spectrum coincide with that of the real spectrum and we multiply each of the points of the reconstituted spectrum by the plate's declivity coefficient

measured by way of photometric calibration. The Figure (preceding page) presents the real spectrum and the recosntituted spectrum corresponding to 700° K.

$$T = 730° K \pm 100° K.$$

We then obtain the same temperature for the three spectra, that corresponds to the temperature at 170 km altitude.

The precision of the method may be brought to $\pm 10° K$ with a spectrograph separating 0.3 Å to 4850 Å.

A value near that temperature was determined by means of a potassium cloud created simultaneously with the explosion. On the other hand, the vibration temperature of AlO may be determined with the same clouds. The comparison of these results, obtained by three methods, will be published, whenever data processing permits it.

*** THE END ***

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